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CLAIMS

1. (canceled)

2. (canceled)

8. (canceled)

9. (canceled)

10. (canceled)

11. (added) A metal molded product production line comprising:

a semi-solid metal producing apparatus for producing a slurry-form semi-solid metal by stirring and cooling a melt contained in a vessel with stirring means having a cooling metal and a viscosity measuring probe to be immersed in the melt; and

a stirring means restoring apparatus for, after the production of the semi-solid metal, carrying out a predetermined restoring treatment on the stirring means.

12. (added) The metal molded product production line of claim 11, wherein the vessel is capable of receiving a predetermined amount of the melt, and the line further comprises:

a molding machine for molding a metal molded product with the semi-solid metal as a starting material;

a carrying apparatus for carrying the vessel from the semi-solid metal production apparatus to the molding machine and feeding the semi-solid metal in the vessel into the molding machine; and

a vessel restoring apparatus for carrying out a predetermined restoring

treatment on the vessel emptied by the feeding of the semi-solid metal into the molding machine.

13. (added) The metal molded product production line of claim 11, wherein the semi-solid metal production apparatus includes an apparatus for measuring a viscosity of the semi-solid metal, the viscosity measuring apparatus comprising:

the stirring means for stirring the slurry-form semi-solid metal in the vessel;

the probe being in the form of a cantilever beam and having a lower part to be inserted in the semi-solid metal;

probe moving means for moving the probe;

a load cell for measuring a force that the probe receives from the semi-solid metal; and

converting means for converting the force detected by the load cell to a viscosity of the semi-solid metal.

14. (added) The metal molded product production line of claim 13, wherein the stirring means restoring apparatus comprises:

cooling means for cooling the cooling metal and the probe of the stirring means by dipping them in water;

coating means for applying a releasing agent to the cooling metal and the probe; and

scraping means for scraping off, before the treatment with the cooling means, semi-solid metal adhered to the probe,

the cooling means having a space compartment designed not to allow entry of water for receiving the probe, a first dipping part for dipping the cooling metal only, and a second dipping part for dipping at least the probe.

15. (added) The metal molded product production line of claim 12, wherein the vessel restoring apparatus comprising:

air blowing means for removing adhered metal inside the vessel while cooling the vessel by blowing air into the vessel;

coating means for applying a releasing agent to the inside of the vessel; and

scraping means for, prior to treatment by the air blowing means, scraping off semi-solid metal adhered to the inside of the vessel.

16. (added) The metal molded product production line of claim 15, wherein the scraping means comprises a scraper installed in a fixed position, the carrying apparatus comprises a multiple-joint robot, and the movement of the robot is controlled such that while gripped by the robot the vessel emptied by the feeding of the semi-solid metal into the molding machine is moved relative to the scraper to scrape off semi-solid metal adhered to the inside of the vessel.

17. (added) A metal molded product production method comprising the steps of:

producing a slurry-form semi-solid metal by stirring and cooling a melt contained in a vessel with stirring means having a cooling metal and a viscosity measuring probe to be immersed in the melt; and

after the production of the semi-solid metal, carrying out a predetermined restoring treatment on the stirring means.

18. (added) The metal molded product production method of claim 17, further comprising the steps of:

after a predetermined amount of the melt is poured from a melt holding furnace into the vessel and the semi-solid metal is produced in the vessel,

carrying the vessel from a semi-solid metal producing apparatus to a molding machine so as to feed the semi-solid metal contained in the vessel to the molding machine; and

molding a metal molded product with the semi-solid metal as a starting material.

19. (added) The metal molded product production method of claim 17, further comprising the step of managing a solid phase percentage of the semi-solid metal, the solid phase percentage management step comprising the steps of:

before the semi-solid metal producing step, preparing a map expressing a correlation between the solid phase percentage and viscosity of the slurry-form semi-solid metal for a given metal composition;

setting a target viscosity corresponding to a target solid phase percentage using the map;

during the semi-solid metal producing step, measuring the viscosity of the semi-solid metal in the vessel while cooling the metal; and

carrying out the cooling until the viscosity reaches the target viscosity,

whereby the solid phase percentage of the semi-solid metal is made to match the target solid phase percentage.

20. (added) The metal molded product production method of claim 19, wherein the stirring means restoring step comprises the step of: cooling the cooling metal and a probe of the stirring means by dipping them in water; and applying a releasing agent to the cooling metal and the probe,

wherein the stirring means restoring step further comprises, before the cooling step, the step of scraping off the semi-solid metal adhered to the probe,

and wherein the cooling step comprises a first step of dipping in water

the cooling metal only and a second step of dipping in water at least the probe, the second dipping step being set to last shorter than the first dipping step.

21. (added) The metal molded product production method of claim 18, further comprising the step of, after the vessel is emptied by feeding the slurry-form semi-solid metal held therein into the molding machine, cooling the vessel for a predetermined time to make the vessel ready for a succeeding pouring of the melt from the melt holding furnace, the predetermined time of the vessel cooling step is determined in correspondence with a temperature of the melt holding furnace and a temperature of the emptied vessel.

22. (added) The metal molded product production method of claim 18, wherein the molding step comprises a die-casting step including the steps of: causing an injecting piston to inject the slurry-form semi-solid metal from a gate; and pouring, via a runner and a weir, the semi-solid metal into a cavity with a sand core disposed therein to thereby provide a cast molding, and wherein the molding step further comprises the step of, before a leading end of the semi-solid metal enters into the cavity, slowing down the piston to reduce a rate of flow of the semi-solid metal.

23. (added) The metal molded product production method of claim 22, wherein the die-casting step comprises causing the injecting piston to slow down at a position 90 to 97% of the way from the injection start position of the injecting piston to the position of the injecting piston when the semi-solid metal first starts to enter the cavity.

24. (added) The metal molded product production method of claim 22, wherein

the cast molding comprises a cylinder block of an engine, and after the casting the sand core is removed to thereby provide a cooling water jacket.

25. (added) The metal molded product production line of claim 11, wherein the semi-solid metal producing apparatus comprises an apparatus for measuring a viscosity of the semi-solid metal,

the viscosity measuring apparatus comprising:

the stirring means for stirring the slurry-form semi-solid metal held in the vessel;

the measuring probe in the form of a cantilever beam having a lower part to be inserted into the semi-solid metal;

means for moving the measuring probe;

a load cell for measuring a force that the measuring probe receives from the semi-solid metal; and

converting means for converting the force detected by the load cell to a viscosity of the semi-solid metal,

the stirring means restoring apparatus comprising:

cooling means for cooling the cooling metal and the probe of the stirring means by dipping them in water;

coating means for applying a releasing agent to the cooling metal and the probe; and

means for scraping off, before the cooling treatment with the cooling means is carried out, scraping off the semi-solid metal adhered to the probe,

the cooling means having a space compartment designed not to allow entry of water for receiving the probe, a first dipping part for dipping the cooling metal only, and a second dipping part for dipping at least the probe, so that the restoring treatment is carried out on the stirring means prior to the stirring of

the slurry-form semi-solid metal.

26. (added) The metal molded product production line of claim 12, wherein the vessel restoring apparatus comprises:

air blowing means for blowing air into the vessel to remove adhered metal inside the vessel and cool the vessel;

coating means for applying a releasing agent to the inside of the vessel; and

scraping means for scraping off, before the air blowing treatment by the air blowing means, the semi-solid metal adhered to the inside of the vessel,

so that after the vessel is emptied by feeding the slurry-form semi-solid metal into the molding machine, the vessel is cooled for a predetermined time while removing adhered metal inside the vessel, to make the vessel ready for a succeeding pouring of the melt from the melt holding furnace, the predetermined time of the vessel cooling is determined on a basis of a temperature of the melt holding furnace and a temperature of the emptied vessel.

27. (added) The metal molded product production method of claim 17, further comprising the steps of: managing a solid phase percentage of the semi-solid metal; and restoring the stirring means,

the solid phase percentage management step comprising the steps of:

before the semi-solid metal producing step, preparing a map expressing a correlation between the solid phase percentage and viscosity of the slurry-form semi-solid metal for a given metal composition;

setting a target viscosity corresponding to a target solid phase percentage using the map;

during the semi-solid metal producing step, measuring, by means of the

measuring probe of the stirring means, with a lower part thereof inserted into the semi-solid metal, the viscosity of the semi-solid metal in the vessel while cooling the semi-solid metal by means of the cooling metal of the stirring means; and

carrying out the cooling until the viscosity reaches the target viscosity,

the stirring means restoring step comprising the steps of:

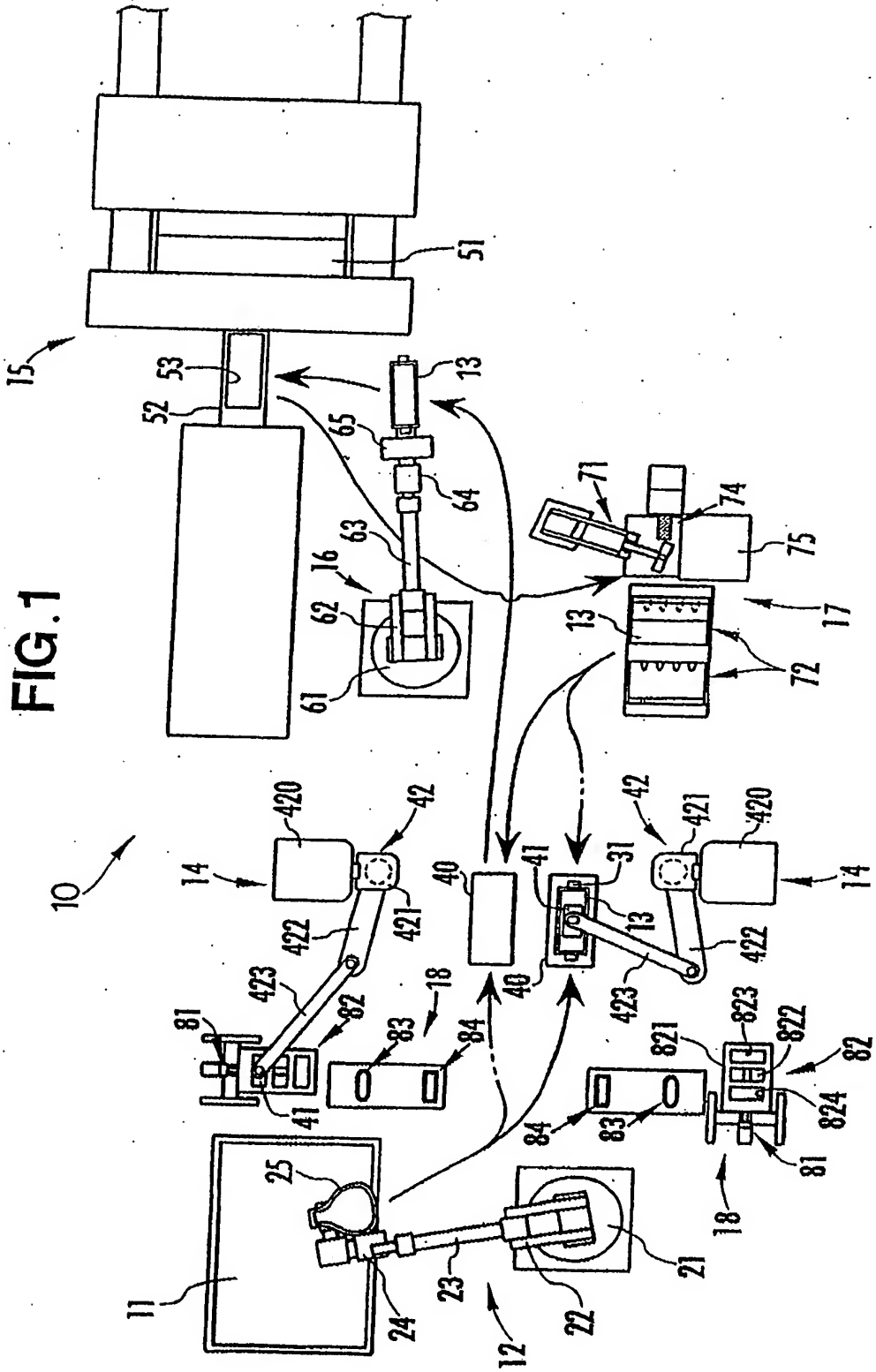
before the semi-solid metal producing step, cooling the cooling metal and the measuring probe of the stirring means by dipping them in water; and applying a releasing agent to the cooling metal and the measuring probe,

the stirring means restoring step further comprising, before the cooling step, the step of scraping off the semi-solid metal adhered to the probe,

the cooling step comprising a first step of dipping in water the cooling metal only and a second step of dipping in water at least the probe, the second dipping step being set to last shorter than the first dipping step,

whereby the solid phase percentage of the semi-solid metal is made to match the target solid phase percentage.

FIG.1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